

# Mucormycosis epidemic within the COVID-19 pandemic in India: An infodemiology study

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## Abstract

**Introduction:** India faced a surge of mucormycosis cases during the coronavirus disease (COVID-19) pandemic. **Materials and Methods:** We used Google Trends to estimate the burden of mucormycosis in the country and to establish its relationship with COVID-19 disease. **Results:** Google search trends for mucormycosis at the national level corresponded with the increase in the actual reported number of mucormycosis cases over the study period. States with maximum COVID-19 cases reported more mucormycosis cases. Trends at the state level showed a rise in mucormycosis case count a few days following the peak in COVID-19 cases. **Conclusion:** The infodemiology approach could be used for disease surveillance during the pandemic to compensate for the scarcity of health-care resources.

**Keywords:** Mucormycosis, COVID-19, Disease Surveillance

## INTRODUCTION

Mucormycosis is a relatively uncommon opportunistic fungal infection, with a prevalence of 0.14 cases/1000 population in India, which is about 70 times the worldwide estimated rate.<sup>[1]</sup>

Coronavirus disease (COVID-19) caused by the severe acute respiratory syndrome coronavirus 2 virus has affected people all over the world. The incidence of mucormycosis has increased following the COVID-19 pandemic in India, particularly in the second wave. Various theories have been postulated regarding the sudden rise, and there are several risk factors for mucormycosis which can be seen in COVID-19 patients. However, the prevalence of mucormycosis in patients with COVID-19 and the relationship between the two is not known.

The shortage of workforce in healthcare with the practical difficulty of doing field studies amidst the pandemic warrants new approaches to disease surveillance. Infodemiology or information epidemiology is a concept of using Internet-derived information for epidemiological studies.<sup>[2]</sup> Studies have used Google Trends search in digital disease surveillance.<sup>[3]</sup>

We used Google Trends data on the topic of “mucormycosis” in India at the national and state level, to explore the relationship between mucormycosis cases reported and online search of mucormycosis. We also evaluated the relationship between mucormycosis cases and COVID-19 cases.

## MATERIALS AND METHODS

Google Trends is an analytical tool that offers an overview of a particular keyword(s) searched for a given

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time and location. It gives the relative search volume (RSV), which is the measure of the frequency of a given search query in the Google search engine, compared to the total number/volume of Google searches conducted in the same geographical region over the selected period. RSV values range from 0 (very low search volumes) to 100 (peak search volume). The official government data of mucormycosis cases dated May 22<sup>nd</sup>, 2021, was the reference point for our case count. We assessed the search trends for 1 month from April 22, 2021, to May 22, 2021, in India using the keywords “mucormycosis,” “black fungus,” and “fungus.” We used “+” to combine the search terms. The search was conducted on May 25, 2021. The details about the COVID-19 and mucormycosis cases were retrieved from the crowd-sourced websites<sup>[4,5]</sup> which compounded data from the government of India releases.

Ethical approval was not required as the research did not involve data collection from human subjects.

## RESULTS

As per Figure 1a, RSV for India at the national's level was persistently <10, till the 1<sup>st</sup> week of May 2021, which gradually increased from the 2<sup>nd</sup> week, and the peak was reached on May 21, 2021.

While only a few cases of mucormycosis were reported in April 2021, whereas there were more than 8500 cases of mucormycosis as of May 22, 2021 [Table 1]. The median number of mucormycosis cases in the different states in India as of May 22, 2021, was 13.5 (interquartile range

**Table 1:** Characteristics of COVID-19 and mucormycosis cases at the state level

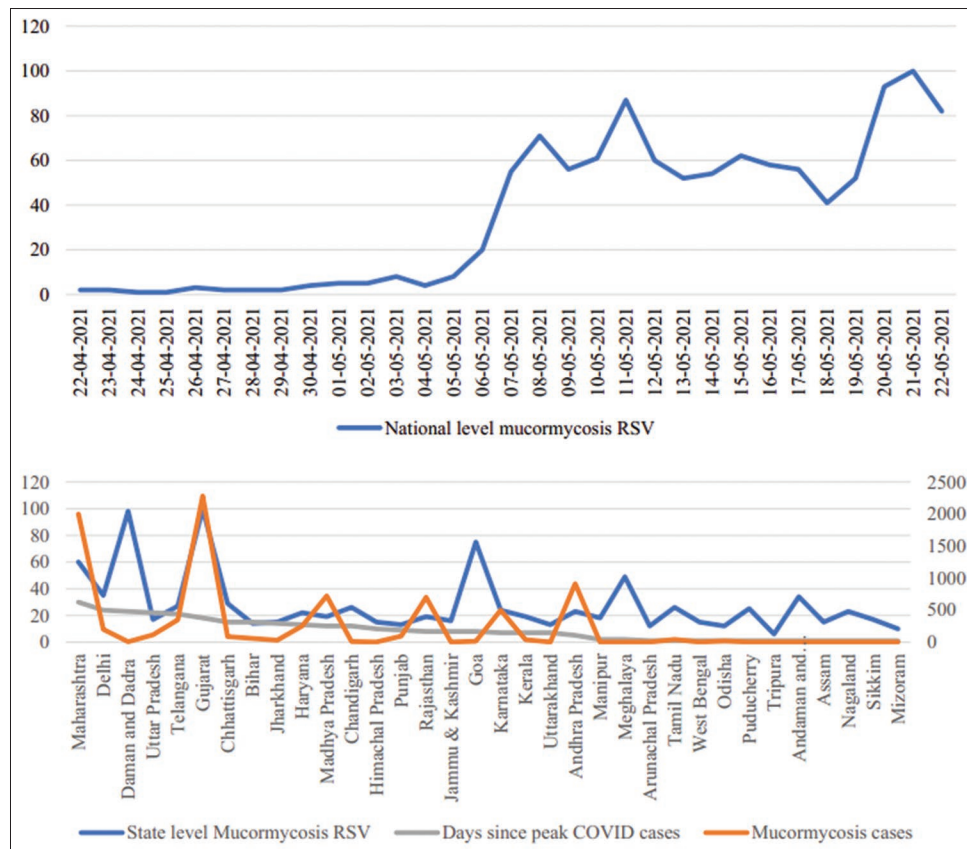
States	Peak active COVID-19 case count	Peak COVID-19 (date)	No of days from COVID-19 peak date to ref date (May 22, 2021)	Total mucormycosis cases (On May 22, 2021)	RSV for Mucormycosis terms (April 22, 2021–May 22, 2021)
Maharashtra	70,1614	April 23, 2021	30	2000	60
Delhi	103,424	April 29, 2021	24	197	35
Daman and Dadra	2081	April 30, 2021	23	6	98
Uttar Pradesh	310,783	May 01, 2021	22	112	17
Telangana	80,695	May 02, 2021	21	350	27
Gujarat	148,297	May 05, 2021	18	2281	100
Chhattisgarh	131,041	May 08, 2021	15	87	29
Bihar	115,152	May 07, 2021	16	56	14
Jharkhand	61,195	May 09, 2021	14	27	15
Haryana	116,867	May 10, 2021	13	250	22
Madhya Pradesh	111,366	May 12, 2021	11	720	19
Chandigarh	8653	May 11, 2021	12	8	26
Himachal Pradesh	40,008	May 15, 2021	8	0	15
Punjab	79,963	May 14, 2021	9	95	13
Rajasthan	211,889	May 15, 2021	8	700	19
Jammu and Kashmir	52,848	May 15, 2021	8	0	16
Goa	32,953	May 15, 2021	8	12	75
Karnataka	605,515	May 16, 2021	7	500	24
Kerala	445,692	May 16, 2021	7	36	19
Uttarakhand	8000	May 16, 2021	7	2	13
Andhra Pradesh	211,554	May 18, 2021	5	910	23
Manipur	6904	May 21, 2021	2	0	18
Meghalaya	6861	May 22, 2021	1	0	49

(Contd...)

Table 1: (Continued)

States	Peak active COVID-19 case count	Peak COVID-19 (date)	No of days from COVID-19 peak date to ref date (May 22, 2021)	Total mucormycosis cases (On May 22, 2021)	RSV for Mucormycosis terms (April 22, 2021–May 22, 2021)
Arunachal Pradesh	2916	May 22, 2021	1	0	12
Tamil Nadu	274,629	May 22, 2021	1	40	26
West Bengal	132,181	May 22, 2021	1	1	15
Odisha	98,610	May 22, 2021	1	15	12
Puducherry	17,936	May 22, 2021	1	0	25
Tripura	7337	May 22, 2021	1	1	6
Andaman and Nicobar Islands	274	May 22, 2021	1	0	34
Assam	54,163	May 22, 2021	1	0	15
Nagaland	4588	May 22, 2021	1	0	23
Sikkim	3175	May 22, 2021	1	0	17
Mizoram	2473	May 22, 2021	1	0	10

States in order as per date of peak of COVID cases



**Figure 1:** (a) Google search trends for mucormycosis search terms at the national level (India) and (b) mucormycosis cases and relative search volume for mucormycosis at the state level (India)

[IQR] 0–210.25). Gujarat had maximum mucormycosis cases among states in India (2281), whereas its RSV for

“mucormycosis search terms” at the state level was 100. There was a direct correlation ( $r = 0.513$ ;  $P = 0.002$ )

between the number of mucormycosis cases in the states and the RSV for “mucormycosis search terms” in each state [Figure 1b].

We assessed the active COVID-19 case trends in every state over the study period. The median number of maximum active COVID-19 cases in the various Indian states was 70,579 (IQR 7,228.75–1,36,210). The total number of mucormycosis cases in each state directly correlated with the peak number of active COVID-19 cases in the respective states ( $r = 0.534$ ;  $P = 0.001$ ). The states which crossed peak active COVID-19 cases earlier had more mucormycosis cases ( $r = 0.483$ ;  $P = 0.004$ ).

## DISCUSSION

We used Google Trends for monitoring mucormycosis cases in India. We established a relationship between the actual COVID-19 disease burden, Google search trends for mucormycosis, and the mucormycosis cases reported in various states.

The earliest peak of the second wave was in Maharashtra, on April 22, 2021, during that time, there were only a few media-reported cases of mucormycosis and the national level RSV for mucormycosis search terms was also as low as two. By May 22, 2021, Gujarat recorded the maximum number of mucormycosis cases. The state-level RSV for “mucormycosis search terms” was also maximum for Gujarat. The direct correlation between the total number of mucormycosis cases and the RSV of “mucormycosis search terms” for individual states highlights that search trends can indicate the burden of the disease. Similar infodemiology approaches using Google Trends were used for monitoring disease burden.<sup>[3]</sup>

States with a higher number of COVID-19 cases and those states which had the peak active COVID-19 cases earlier reported more mucormycosis cases. The findings suggest that mucormycosis in patients with COVID-19 disease also developed a few days after the active COVID-19 infection. Various factors could have contributed to the development of mucormycosis after active COVID-19 infection.

The hyperinflammatory phase of COVID-19 disease is associated with multisystem involvement and the cytokine release syndrome.<sup>[6]</sup> Multiple treatment modalities are used for suppressing the inflammatory response, such as corticosteroids, and interleukin 6 antagonists such as tocilizumab. The flipside of these therapies is immunosuppression and increased opportunistic infections.<sup>[7]</sup>

An alarmingly higher (73.6%) association was found between uncontrolled diabetes mellitus and invasive

zygomycosis.<sup>[8]</sup> The widespread use of steroids in the management of COVID-19 and poor glycemic control might escalate risk. Data estimates 46% of the patients had received corticosteroids within 1 month before the diagnosis of mucormycosis.<sup>[9]</sup> Antibiotic usage, which has gone up in the COVID-19 era,<sup>[10]</sup> could be another contributing factor. We could not find substantial evidence for other factors such as the use of industrial-grade oxygen, excessive zinc supplements, and reuse of masks.

Limitations of the study include knowledge levels of the sample population, missed cases, and accessibility to the Internet.

## CONCLUSION

The present study suggests a surge in mucormycosis post-COVID-19 infection. Risk factors such as steroid use and uncontrolled diabetes mellitus could have contributed to the development of mucormycosis. Although not an accurate representation of ground reality, the Google Trends data can be taken as a gross surrogate marker of disease prevalence which can serve as an additional tool for the policymakers.

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